PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTONAMERICAN CAUDATA. VI. THE RACES OF
EURYCEA BISLINEATA

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The collection of considerable numbers of two-lined salamanders in Indiana, and the necessity of establishing their subspecific identity in connection with a forthcoming report on the herpetology of this state, has prompted me to compare these specimens with extensive series of two-lined salamanders from other parts of the range of this species. Reynolds and Black (1936: 293) pointed out that specimens from Parke County, Indiana, are more similar to *Eurycea bislineata cirrigera* and *E. b. wilderae* in having 14 costal grooves, than to *E. b. bislineata* which is generally characterized as having 15 grooves. The majority of my material agrees with Reynolds and Black's description, and since standard references (Stejneger and Barbour, 1943; Bishop, 1943; Dunn, 1926) are in accord in considering Indiana two-lined salamanders referable to *bislineata*, the situation seems amenable only to a thorough-going study of the entire status of racylation in *Eurycea bislineata*. Racial identification of the Indiana two-lined salamanders inevitably depends on the definitions of *bislineata* and its subspecies.

Unfortunately, as pointed out by Dunn (1926: 297), Green designated neither type specimens nor a type locality for his *Salamandra bislineata*. Stejneger and Barbour (1943: 30) suggest Princeton, N. J., as the type locality, and for practical purposes, I have considered specimens from the northern half of New Jersey as "typical" of *bislineata*. Such specimens are fairly homogeneous in having 15 or 16 costal grooves (counting inguinal and axillary branches) with about equal frequency, and in having a combined vomerine tooth count (the sum of both vomerine series) varying from 8 to 18. The color and pattern vary somewhat, but the dark brown dorso-lateral stripes usually extend for about half the length of the tail (occasionally less, rarely more); the sides of the body are sometimes immaculate, but are more often stippled with

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gray or brownish, and occasionally there is a series of light spots running parallel to—and immediately below—the dorso-lateral dark stripe. There is often a small swelling, or tubercle, at the base of the naso-labial groove on the upper lip, in sexually active males, and occasionally also submental and caudal hedonic swellings.

Salamanders agreeing with this definition are found from eastern Quebec to southern Virginia, and west through the Appalachian uplift almost to the Ohio River in West Virginia. Out of 210 sexually mature specimens of both sexes from this region, 110 (= 53%) have 15 costal grooves, while the remaining 100 specimens have 16 grooves; there is no association between the costal groove count and age, sex, or geographic origin. The combined vomerine counts in this series vary from 8 to 21, average 12.2 ± 3.07 , and as in the case of the costal grooves, are not associated with age, sex, or provenance. A maximum total length of 109 mm. is found in this series (♀, Harrison, Westchester County, New York, personal collection M. B. Mittleman). The ratio of tail length to total length in metamorphosed specimens is from 46.7% (in a specimen with a total length of 47 mm.), to 59.5% (in a specimen with a total length of 96 mm.)¹.

Although relatively widely distributed and comparatively stable morphologically, the two-lined salamander undergoes several changes in the southern portion of its range, and evolves ultimately into two distinct forms, *cirrigera* and *wilderae*. In the Atlantic and Gulf Coastal Plain, and the Piedmont, the two-lined salamander population is characterized by a costal groove count of 13 or 14, a combined vomerine count of 10-24 (average 15.8 ± 2.54), a more intense pigmentation with the dorsolateral stripe usually extending to the distal fourth (or even tip) of the tail, a well-developed lateral series of white (or at least light) spots, and prominent cirri in sexually mature males. These are the characteristics of the race *cirrigera* which extends from southern Virginia through the Coastal Plain to northern Florida and extreme eastern

¹My findings concerning the ontogenetic variation in proportionate tail length in *bislineata* are almost identical with those of Oliver and Bailey (1939: 200), and I agree with them in considering *E. bislineata major* Trapido and Clausen (1938: 119) to be synonymous with *E. b. bislineata*. A count of 17 costal grooves occasionally occurs in *major* (*vide* Trapido and Clausen, *l.c.*); this results from the anomalous branching of either the first or last costal groove, and is not normal. The type of *major* (USNM 104239 ♂, Val Jalbert, Ouiahouan River, Lake St. John Co., P. Q.) has 16 costal grooves, a tail/total length ratio of 56.5%, and a combined vomerine count of 14. Two paratypes (USNM 107208-9) from Bonaventure Co., P. Q., are similar in all respects, and like the type, are indistinguishable from many *bislineata*.

Louisiana, and inland through the Piedmont generally to the border of the Blue Ridge Province, in the Carolinas and Georgia.

The montane two-lined salamander of the Blue Ridge Province, *wilderae*, is similar to *cirrigera* in normally having 13 or 14 costal grooves (rarely, an anomalous branch of the first or last groove results in a count of 15), and prominent cirri in sexually mature males. It differs from *cirrigera* in having fewer vomerine teeth, the combined vomerine counts ranging from 4 to 17, average 11.4 ± 3.33 ; *wilderae* is also distinguished in that the heavy black (rather than brown) dorsolateral stripes stand out sharply (not tending to fuse with the pigments of the sides of the body and tail), and rarely extend beyond the middle of the tail. The range of *wilderae* is from White Top Mountain, Virginia, south through the Blue Ridge Province to Rabun and Gilmer counties, Georgia, and west to Sevier County, Tennessee.

Two-lined salamanders from Brunswick and Mecklenburg counties, Virginia (RLH² 955, 966-8), are characteristic *cirrigera*; however, specimens from Buckingham, Charlotte, and Prince Edward counties, Virginia (RLH 952-4), have the teeth of *bislineata* (combined vomerines 7, 12, 12), 14 costal grooves as in *cirrigera*, and an intermediate color and pattern. I regard them as intergrades; Dunn (1926: 303) has recorded intergrades of *cirrigera* \times *bislineata* from Midway and Gloucester, Virginia.

Specimens from the extreme southern Piedmont in Georgia are difficult to assign racially. Two-lined salamanders from Rabun and Gilmer counties are referable to *wilderae*, as noted by Dunn (1926: 313; also WTN 7022-3, betw. Tiger and Wylie, Rabun Co.), although they are somewhat aberrant in having higher combined vomerine counts (12, 20) than is usual in this race. Specimens from Tray Mountain, Habersham County (USNM 115622-5) are definitely aberrant; they display the vomerine counts of *cirrigera* in three out of four specimens (12, 16, 18, 18), and have a more intense pigmentation than is normal for *wilderae*. Specimens from Duluth, Gwinnette County (USNM 91809-11) are similar, and have a pattern intermediate between *wilderae* and *cirrigera*; two of the three specimens have combined vomerine counts of 12, and one has

²Abbreviations used for collections: RLH = private collection of Richard L. Hoffman; WTN = private collection of Wilfred T. Neill; CAS = Chicago Academy of Sciences; USNM = United States National Museum; OUZ = Department of Zoology, Ohio University.

a count of 19. On the other hand, specimens taken barely forty miles to the east, in Clarke County (WTN 7543-6, 7565, 7583), have patterns which are very similar to those of Coastal Plain *cirrigera*; two of the six specimens have the characteristically high vomerine count of *cirrigera* (17, 20), while the other four have low to moderate counts (5, 8, 10, 14). The single male in this series has no cirri, although it is large (snout-vent 45 mm.) and has a fairly prominent caudal hedonic swelling. Specimens from Augusta (which is on the Fall Line) display all of the usual characteristics of *cirrigera*, and I conclude that this city and its surrounding area marks the northernmost limit of "typical" *cirrigera* in Georgia.

In addition to the differentiation which the two-lined salamander undergoes in the southern part of its range, still other changes occur in the populations lying to the west of the Alleghanian uplift, for these transmontane salamanders differ in several respects from *bislineata* and its races *wilderae* and *cirrigera*. In these specimens the costal groove count is normally 14 (81% of specimens), less often 15 (18.2% of specimens) or 16 (0.8% of specimens), thereby distinguishing them from *bislineata*. The combined vomerine counts range from 8 to 27, average 15 ± 3.73 , which likewise serve to differentiate these specimens from *bislineata* and *wilderae* (although not from *cirrigera*). The color and pattern approximate *bislineata*, although the common presence of fairly well developed light spots on the sides is strongly reminiscent of *cirrigera* (as is also the extension of the dorsolateral stripe to the tip, or the distal fourth of the tail, in many specimens). The lack of cirri in sexually mature males suggests *bislineata*, rather than *wilderae* or *cirrigera*, although occasional specimens have pronounced, even slightly elongate, swellings at the base of the naso-labial grooves. In sum, this population is most similar to *bislineata* in color and pattern and lack of extreme sexual dimorphism; it is closest to *cirrigera* in dentition and costal groove count. The transmontane population and *cirrigera* differ considerably in limb length, for the latter is a long-legged form, while the former has rather short legs. In transformed *cirrigera* of 35+ mm. snout-vent length, the appressed limbs sometimes just meet, but are more often separated by one or two costal spaces, the usual condition being about one and a half spaces. Transmontane specimens of comparable snout-vent lengths almost invariably have a great-

er number of costal spaces between the appressed toes; in this population two to four and a half spaces are found between the appressed limbs, usually about three.

It is obvious that the transmontane specimens are not identifiable with any of the earlier-described races of the two-lined salamander, and since they are nameless, I propose to call them

Eurycea bislineata rivicola, n. ssp.

HOLOTYPE.—An adult male in my personal collection (to be deposited in the U. S. National Museum), taken in Echo Canyon, McCormick's Creek State Park, Owen County, Indiana, by Mary E. and M. B. Mittleman, August, 1942.

ALLOTYPE.—An adult female in my personal collection, same data as the holotype, to be deposited in the U. S. National Museum.

PARATYPES.—(I have examined several hundred specimens, and still more are extant from a great many localities; rather than enumerate all of these, I have selected as paratypes only a sufficient number of specimens to illustrate the geographic and morphologic range of this race), WEST VIRGINIA—*Wood County*: 5 mi. S. of Parkersburg (OUZ 924); *Mingo County*: Varney (OUZ 933). OHIO—*Athens County*: Canaan Twp., Sec. 11 (OUZ 28-9); *Carroll County*: no specific locality (OUZ 906); *Hamilton County*: Cincinnati (USNM 8832); *Hocking County*: Salt Creek, Benton Twp. (OUZ 1028, 13 spec.); *Monroe County*: Adams Twp., Sec. 6-36 (OUZ 946, 2 spec.); *Preble County*: 5 mi. SE of Camden (USNM 76825-6); *Washington County*: Marietta (USNM 118302-6; OUZ 945, 6 spec.). KENTUCKY—*Carter County*: Carter Caves (OUZ 1058, 6 spec.), Cascade Cave (OUZ 1029). INDIANA—*Brown County*: Brown County State Park (10 spec., MBM coll.), Pike's Peak (5 spec., MBM coll.); *Jennings County*: Muscatatuck State Park (4 spec., MBM coll.); *Marion County*: Indianapolis (USNM 17465-8; 10 spec., MBM coll.); *Monroe County*: Morgan-Monroe State Forest (2 spec., MBM coll.); *Owen County*: McCormick's Creek State Park (8 spec., MBM coll.); *Parke County*: Turkey Run State Park (CAS 1436-64); *Tippecanoe County*: Lafayette (USNM 17972-4). ILLINOIS—*LaSalle County*: Starved Rock (CAS 1573). TENNESSEE—*Cheatham County*: 2 mi. S. of Shacklett (USNM 85686); *Cumberland County*: 3 mi. E. of Pleasant Hill (USNM 87615); *Davidson County*: 5 mi. NW of Belleview (USNM 85689); *Grainger County*: Bean Station (USNM 88754); *DeKalb County*: Dowelltown (USNM 88755).

DIAGNOSIS.—A race of *Eurycea bislineata* usually having 14 costal grooves (81% of specimens), less often 15 or 16 grooves (19% of specimens); costal spaces between appressed toes two to four and a half, usually three; combined vomerine count 8-27, average 15 ± 3.73 ; no cirri in sexually active males; dorsolateral stripe extending well beyond the middle of the tail in most specimens, often reaching the tip.

DISTRIBUTION.—Extreme western West Virginia at low altitudes, west to central and northern Illinois and southwestern Michigan, Tennessee between the Blue Ridge and the west branch of the Tennessee River.

REMARKS.—The distributional limits of *rivicola* are known only imperfectly. Material from West Virginia indicates that this race occurs only in the extreme western part of the state, apparently only below the 1,000 foot contour along the Ohio River Valley; whether *rivicola* enters Pennsylvania in the extreme western portion of the state is uncertain, two specimens from Meadville, Crawford Co. (USNM 3718, 2 spec.) being quite typical *bislineata*. The westernmost limits of *rivicola* are Will, LaSalle, and Edgar counties, Illinois; presumably, the Berrien County, Mich., record for *bislineata* (Maldonado-Koerdell and Firschein, 1947: 140), which I have not examined, is referable to *rivicola*.

I have not seen any specimens from Coastal Plain Tennessee, *i.e.*, that portion of the state lying to the west of the Tennessee River, but I suspect that this population will show a prominent tendency toward *rivicola*, if not actual identity with this race. Parker (1947:79) has reported *cirrigera* from northwestern DeSoto Co., Mississippi, but the specimens I have examined from this county (1 mi. E. of Walls, CAS 10847, 10 spec.) are actually intergrades between *cirrigera* and *rivicola*, and on the whole are closer to the latter race. In pattern and dentition they are intermediate, while in the costal groove count (14 in seven specimens, 15 in three) and number of costal spaces between the appressed limbs (3 or 4 in all specimens) they suggest *rivicola*, as does also the lack of cirri in the sexually mature male of this series. If these specimens are correctly identified as intergrades, then it is probable that *rivicola* extends into extreme western Tennessee, and the northernmost parts of Mississippi and Alabama as well.

Eastward in Tennessee, *rivicola* is found as far as Grainger County (Bean Station, USNM 88754, at an altitude of approximately 2,000 feet. King (1939: 557-9) has described specimens of "*Eurycea bislineata* × *cirrigera*" from low altitudes (below 2,500 feet) in the Great Smokies, in Sevier County, Tennessee, which appear to be *rivicola*; King's description fits *rivicola* in all important respects, except the number of costal spaces between the limbs. Interestingly enough, King reports no instances of intergradation between *wilderiae* and his "*Eurycea bislineata* × *cirrigera*" (= *rivicola*), which may be due to the fact that the former takes up a semi-terrestrial existence, while the latter, according to King, is restricted to springs, marshy areas, and small streams. Dunn (1926: 303) reports intergradation between *wilderiae* and *bislineata* at Abingdon, Washington Co., Virginia.

The four races of *Eurycea bislineata*, as recognized and defined in this paper, may be identified by the following key:

- 1a. Costal grooves 15 or 16; occasional naso-labial swellings or tubercles, but no cirri present in sexually mature males 2
- 1b. Costal grooves 13 or 14; if cirri are present, costal spaces between the appressed limbs are 2, if cirri are absent there are 3 costal spaces between the appressed limbs 3
- 2a. Combined vomerines 8-21, average 12; dorsolateral stripe usually not extending beyond middle of tail. Southern Quebec to southern Virginia, west to the Ohio River valley in West Virginia *bislineata*

- 2b. Combined vomerines 8-27, average 15; dorsolateral stripe usually extending well beyond middle of tail (to distal fourth or beyond). Ohio River valley in West Virginia, west to central and northern Illinois, and extreme southwestern Michigan, Tennessee between the Blue Ridge and the west branch of the Tennessee River *rivicola*
- 3a. Costal spaces between the appressed limbs usually 2; cirri present in males 4
- 3b. Costal spaces between the appressed limbs usually 3; no cirri present in males. Range as in 2b *rivicola*
- 4a. Combined vomerines 10-24, average 15.8; sides dark with prominent white (or light) spots; dorsolateral stripe extending to tip, or at least the distal fourth, of tail. Southern Virginia to extreme Louisiana in the Coastal Plain and Piedmont .. *cirrigera*
- 4b. Combined vomerines 4-17, average 11.4; sides light, dorsolateral stripe black (rather than brown) and extending only to the middle of the tail. The Blue Ridge Province, from White Top Mountain, Virginia, to Rabun and Gilmer counties, Georgia *wilderae*

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Plate.—Distribution of the races of *Eurycea bislineata* (modified after Bishop, 1943: 405). Intergradation between races is not shown, except

in the case of *wilderae* \times *cirrigeria*. The inclusion of northern Alabama and extreme northwestern Georgia in the range of *rivicola* is based on the expected, but as yet hypothetical, extension of this subspecies' distribution. The distributional vacuum in northwestern Alabama, northern Mississippi, and western Tennessee is purely artificial; *Eurycea bislineata* cap. occurs in this area, but the status of the form is as yet uncertain. Similarly, some race occurs in extreme western Kentucky, but whether it is *cirrigeria* or *rivicola*, or an intergradant population, is not known. The range boundary of *rivicola* and *bislineata* in northeastern Ohio and western Pennsylvania is artificial; whether the two races interdigitate or replace each other abruptly in this region remains to be determined.

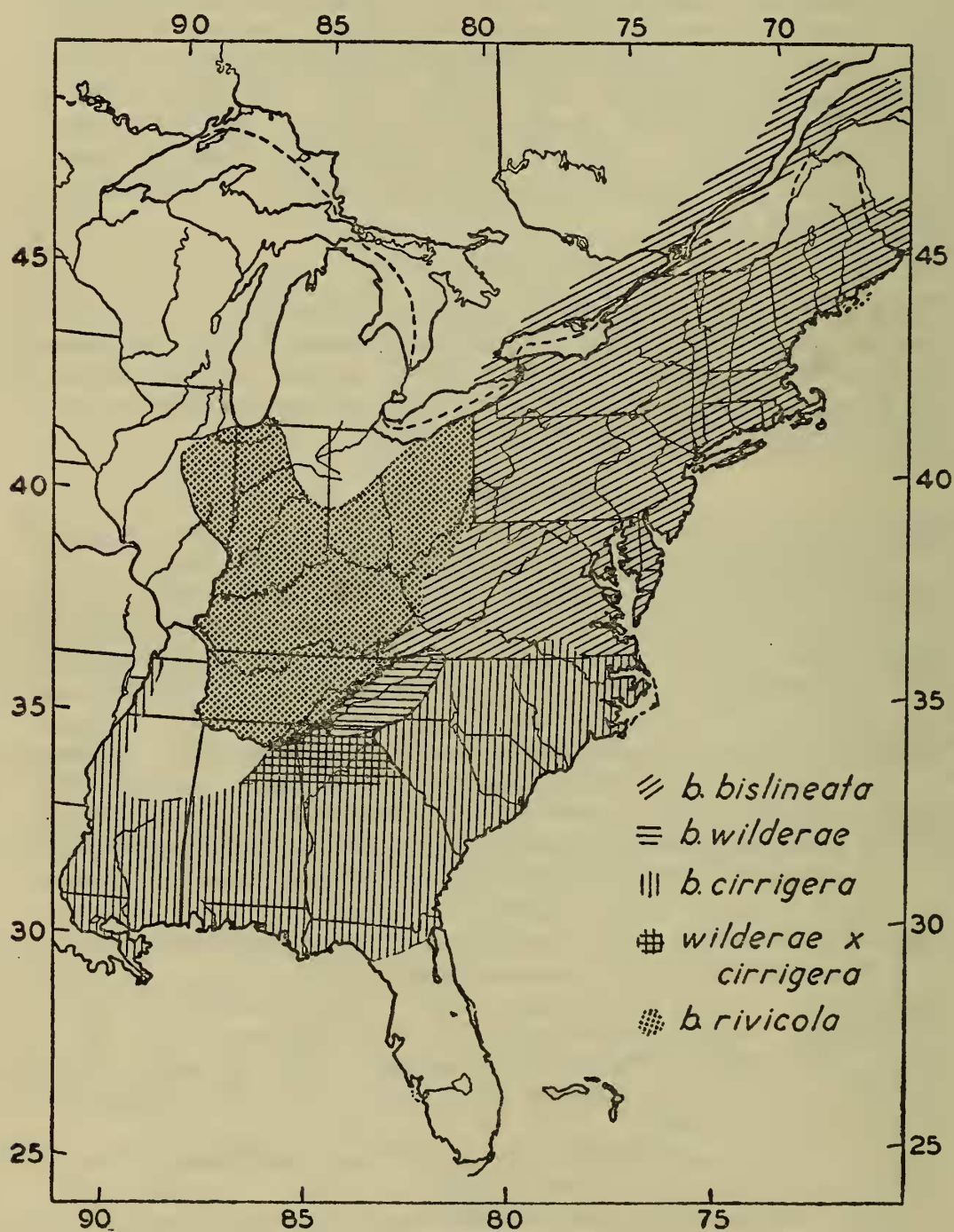


PLATE VI